ABSTRACT

A laboratory-scale investigation was carried out to examine the applicability of four-stage across-the-flow Rotating Biological Contactor (RBC) reactor in the treatment of synthetic waste water containing phenol and/or thiocyanate. In the case of combined treatment of phenol and thiocyanate, the composition of synthetic waste water was maintained in such a way that the ratio of phenol to thiocyanate approximated to that found in coal carbonization effluent.

At the outset of this investigation programme, hydraulic regime of RBC was examined while in the second phase, the treatment performance and kinetics of phenol removal were studied. In the final phase, the degradation pattern of synthetic waste water containing phenol and thiocyanate was observed in the said reactor.

It was noticed that the RBC reactor neither followed, hydraulically, ideal completely-mixed nor ideal plug-flow pattern but the flow regime lay in some intermediate region approaching plug-flow with axial dispersion. The same was found to be a function of operating variables, namely, liquid flow rate, number of stages, rotational speed and submergence of discs. A regression model has been developed for the prediction of dispersion number at various combinations of dimensionless parameters like Reynold's number (R_e), Froude's number (F_R) and Dimensionless length (L_R).

It was noted that more than 90% removal of phenol could be obtained in the RBC reactor in only six hours of hydraulic retention time (HRT). The reaction of phenol bio-degradation followed first-order and K_e value was found to be around 0.10 per hour; K_m value varied from 0.46 to 1.40 mg/L; and K'' ranged from 6.0×10^{-3} to 6.2×10^{-2} m^3/day.

As regards the combined treatment of phenol and thiocyanate based waste water, it was seen that substrate removal was guided by the priority of bio-degradation mechanism i.e, affinity of microbes towards selective substrates rather than either the hydraulic regime of the reactor or the respective kinetics of their microbial degradation. In this case, phenol was mostly removed in earlier stages viz, first and second while thiocyanate-fed microbes acted more efficiently in the latter stages (third and fourth) where inhibition due to phenol was considerably less.

The overall reaction rate coefficient for phenol bio-degradation (K_{PH}) varied from 10.2 to 3.5 $gm/m^2/day$ in the presence of (0-240) mg/L of input thiocyanate concentration. The same coefficient for thiocyanate bio-degradation (K_{TH}) was found to be in the range of 7.35-0.30 $gm/m^2/day$ in the presence of (0-240) mg/L input phenol concentration.

The present study would, therefore, help environmental engineers and scientists conceptualize an aerobic biological system for the combined treatment of industrial waste waters containing toxic substances such as phenol and thiocyanate.

The investigation also provides the waste water treatment engineers some useful insights into the hydraulic characteristics of a segmented RBC reactor and the utilization of the reactor for the integrated treatment of industrial waste waters such as coal-gasification effluent.

KEY WORDS :

bench-scale; dimensionless length; dispersion number; disc rotation; Froude's no.; hydraulic regime; hydraulic retention time; kinetics; mass-transport; microbial growth; phenol-thiocyanate system; reaction rate; Reynold's no.; rotating biological contactor; selective bio-degradation; staging; substrate input; temperature; waste water.